CHAPTER 13:
EXPERIMENTS & OBSERVATIONAL STUDIES

Observational Studies:

* researchers **do not** impose a treatment on the exp. units. Simply observe Ex: Survey

2 types of studies:

Retrospective Study:

* Select exp. units and then ask about previous behaviors & conditions

Prospective Study:

* Identify exp. units in advance and then collect data as events unfold (follow them)

Example: Researchers looked at records of tenants at an apartment building over the past 5 years to determine if the landlord had a preference in the race of his tenants.

retro

Example: A local school identifies 50 kindergartners who are considered "at risk" students, and tracks their progress thru high school graduation to see if the programs already in place in the district help these students.

pro

Example:

You work for botanical company and with your team you have developed a new type of potting soil specifically designed to improve the growth and development of roses. An experiment needs to be designed to show that your soil works well compared to regular soil and the leading competitor.

How can you design a good, random, experiment?

- multiple trials
- limit lurking variables
- similar exp. units
- control group

Some vocab...

Experiments:

* Impose a treatment

* manipulate factor levels to create treatments

* randomly assign subjects to these treatment levels

* compare the responses of the subject groups across treatment levels

Experimental Units-

* Individuals on which the experiment is done

Ex: Animals, plants, cars, etc.

Subjects-

* Human experimental units

Factor-

* explanatory variable(s) General Weight loss

Ex: diet & exercise

* levels controlled by the experimenter.
* Experimenters try to discover how different factor levels affect the responses of the experimental units. *Ex: response = weight*

Example: measuring the affect of 2 fertilizers and 3 water amounts on plant growth.

Factors = Fertilizer and Water

Level-

* The specific values a factor can take

Ex: diet: Low carb or Vegetarian
exercise: None or Moderate

Treatments-

* a combination of levels of each factor (if there's more than 1 factor)
* the ***SPECIFIC*** thing being done to each group of experimental units

Ex: LC & None LC & Moderate
Veg & None Veg & Moderate

Example: measuring affect of 2 fertilizers and 3 water amounts on plant growth.

Factors = Fertilizer and Water

Levels = Fertilizer: A and B Water: 100mL, 200mL, 300mL

Treatments = A & 100mL A & 200mL A & 300mL
B & 100mL B & 200mL B & 300mL

Response Variable-

* What is measured and used for comparison
* Can be more than one thing

Example: plants and fertilizer and water again

Response variables = height of plant in inches
width of plant in centimeters
number of buds on plant
number of leaves on plant
color of plant

When designing experiments...

PRINCIPALS OF EXPERIMENTAL DESIGN

1) CONTROL:

* As many aspects of the experiment as possible
* Anticipate & Reduce effects of lurking variables (try to control them)
* Use a control group

2) RANDOMIZATION:

* Of exp. units into treatment groups

- Assign each exp. unit in the sample a number

- Use TRD to assign exp. units as evenly as possible to treatments

3) REPLICATION:

* of expt. on many different exp. units
* of expt. on many different samples from same population
* helps show validity of results if you replicate and see same results

Some more vocab...

Control Group –

* experimental units assigned the baseline treatment: either no treatment, the default (old) treatment, or placebo

*can't harm subjects

Placebo –

* Try to use when you have subjects (people)
* a treatment known to have no effect, a dummy treatment.
* VERY SIMILAR to real treatment size, taste, smell, look, etc...

Placebo Effect- *(add to your notes)*

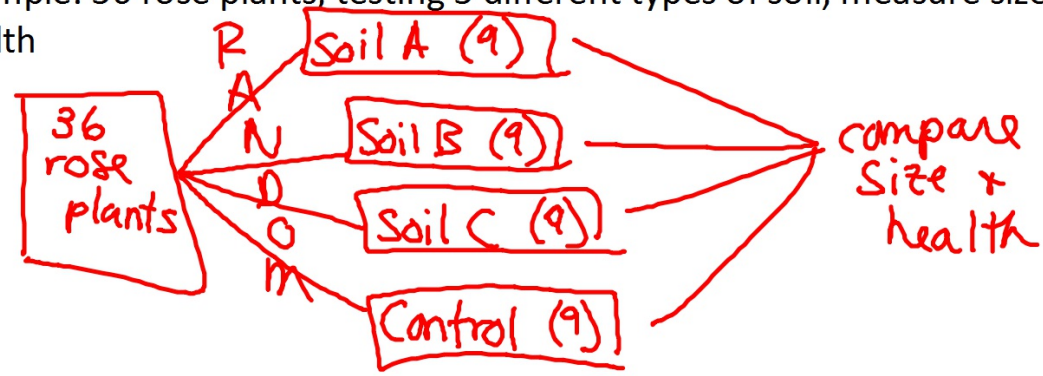
* The tendency of many human subjects to show a response even when administered a placebo.

EXPERIMENTAL DESIGNS

(1) Completely Randomized Design (CRD)- randomly & evenly assign exp. units to treatments

Design:

Example: 36 rose plants, testing 3 different types of soil, measure size and health



Other vocab:

- ***Single blind:***
  - When one group (the exp. units or researchers recording results) do not know which exp. unit is getting which treatment

- ***Double blind:***
  - When ***both groups*** (the experimental units and the researchers recoding the results) don't know who is getting which treatment

**Try to use blinding if possible- it reduces possible bias

Example 1: I want to test out a new plant food. So I take 20 plants, and give half the new plant food and half no food at all. All of the plants get the same amount of water and sunlight each day. After 30 days, I measure the height that the plant has grown, and also how many flowers it has on it.

Individuals:
Factor(s):
Level(s):
Treatment(s):

Response Variable:

Design the experiment:

Example 2: High cholesterol level in people can be reduced by exercise or by drug treatment. A pharmaceutical company developed a new cholesterol-reducing drug. Researchers would like to compare the effects of the new drug with the currently used and accepted drug. 100 Volunteers who have a history of high cholesterol and who are currently not on any medication will be recruited to participate.

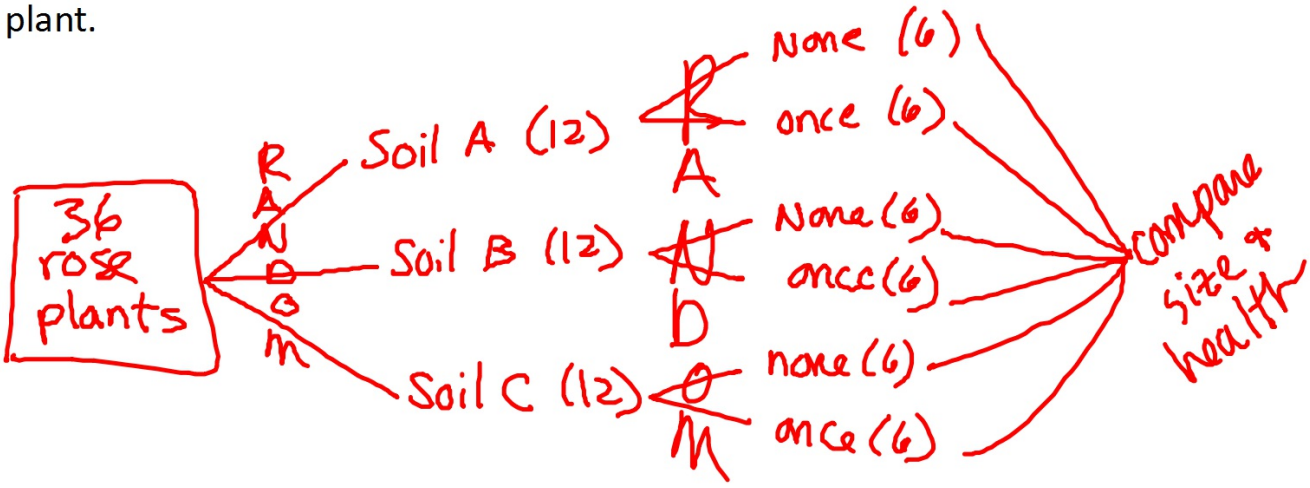
What are the treatments? What are the subjects/individuals?

What is the response variable?

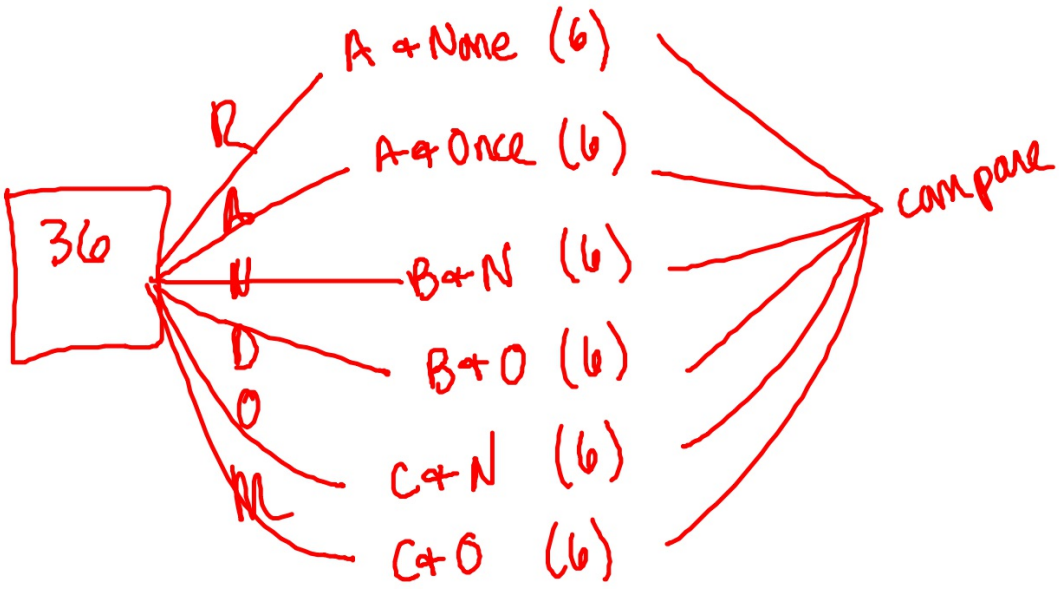
Would a placebo group be appropriate/necessary? Why or why not?
Design the experiment below:

(2) Two Factor Design:

Design:Example: 36 rose plants, testing 3 different types of soil and 2 amounts of water (none or once a day). Still measuring size and health of plant.



Other option with 2 factors:

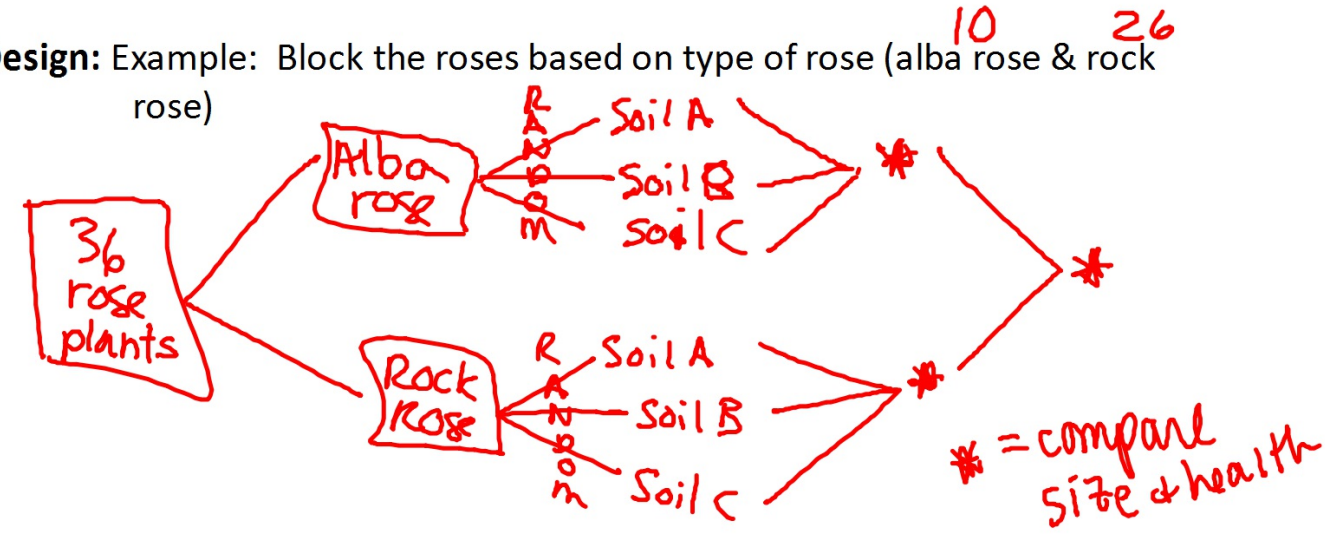


(3) Block Design (Blocking)

BLOCK = group of similar exp. units that would have an effect on the results. Used to reduce effects of lurking variables.

Examples: gender, age, breeds, etc.

Design: Example: Block the roses based on type of rose (alba rose & rock rose)



Example 3: Let's go back to the experiment on people with high cholesterol. We wanted to test the effect of new and old drug. We also thought a control group would be useful. There are 100 volunteers with high cholesterol that are currently not on meds that are available.

What are some lurking variables in this experiment?

Using this variable, create a block design experiment

Example 4: Men and women respond differently to advertising. An experiment to compare the effectiveness of 3 TV commercials for the same product will want to look separately at the reactions of the different genders, and assess their overall responses to the ads. There are 70 people available for the experiment.

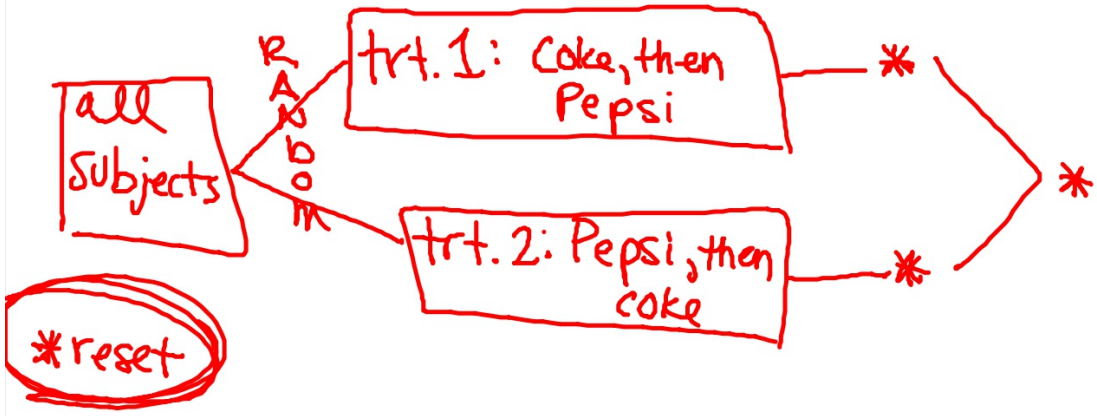
What is the lurking variable in this experiment?

Using this variable, create a block design experiment

(4) Matched Pairs Design

- Usually only 2 treatments
- ***Each exp. unit gets both treatments***
- Randomize which treatment comes 1st/2nd (or L & R, or back/front)
- Can also be where two subjects with equal characteristics are given different treatments and then compared. *Ex: twins, married couple*

Design: Example- taste test (coke vs. pepsi)



Example 5:

We want to test the effectiveness of two types of tires (call them A and B) on cars. We gather 50 different cars for our experiment. We will be measuring the amount of wear on the two types of tires. The cars will be driven normally for 3 months. How could we BEST design this experiment?

(A) What are the exp. units (individuals)? What is the response variable?

cars

wear on tires

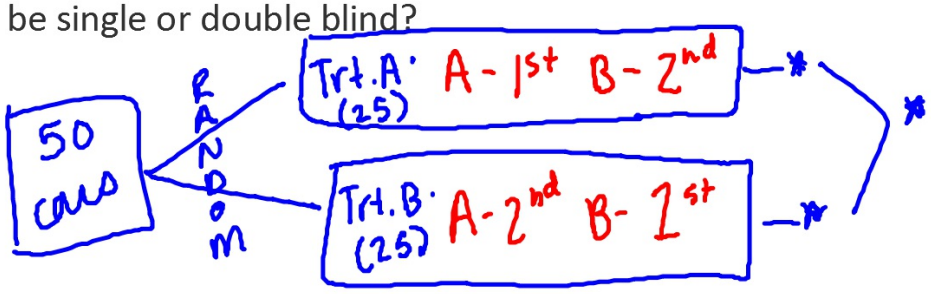
(B) What are the treatments?

A and B

(C) Design the experiment (matched pairs):

* = compare tire wear

(D) Can this experiment be single or double blind?



Example 6:
Go back to the car tires experiment. Suppose the cars were all different (SUVs, sports cars, sedans, trucks, etc.). How would you reduce this lurking variable of car size/type?

** you can block in any experiment, if you feel it is necessary**

The best experiments are usually:

- Randomized
- Double-blind
- Comparative
- Placebo-controlled

Confounding –

* when levels of one factor are associated with the levels of another factor so their effects cannot be separated Ex: water & fertilizer

Lurking Variable –

* variable that has an important effect on the relationship among variables but is not included in the study/expt.
  Ex: sunlight

Statistically Significant –

* seeing an observed result (or difference) so often, that it is most likely not due to chance, and instead is the true response in the study/expt.

Example: #41 in book:

A study published in *New England Journal of Medicine* suggests that it's dangerous to enter a hospital on the weekend. During a 10-year period, researchers tracked over 4 million emergency admissions to hospitals in Ontario, Canada. Their findings revealed that patients admitted on weekends had a much higher risk of death than those who went on weekdays.

(a) The researchers said the difference was statistically significant. What does this mean in context?

(b) What kind of study was this?

(c) If it is Saturday, and you are feeling really sick, should you wait til Monday to seek medical help?

(d) Suggest some possible confounding or lurking variables.

Example worksheet

AP PROBLEMS!